DIGITAL VIDEO SIGNAL PROCESSING APPARATUS OF MOBILE COMMUNICATION SYSTEM AND METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

[1] The present invention relates to video signal processing, and more particularly to a system and method for processing video signals transmitted among a plurality of users during a video conference.

2. Background of the Related Art

[2] Various multimedia services have been provided through a mobile communication terminal, and recently users have taken an interest in video communication services.

[3] First-generation video communication services provided point-to-point service. Recently, research has focused on providing multipoint video communication services based on the first-generation video communication service. To provide multipoint video communication services, video signals must be efficiently processed from a plurality of users.

[4] Video conference is a representative example of a multipoint video communication service. In a video conference system, plural participants exchange images and voices through their terminals.

[5] Figure 1 is a block diagram illustrating a general multipoint video conference system, where there are four participants. The system includes plural video conference

terminals 10 each having a video camera 10a, and a MCU (multipoint control unit) 20 for processing/converting video signals from each of the video conference terminals 10 and then generating a new video signal based on each of those signals.

[6] The MCU maintains and manages a multipoint video conference based on a H.32x terminal standard. This involves generating and transmitting a new video signal to each of the video conference terminals in a resolution appropriate to each of the video conference terminals. To perform these functions, the MCU 20 includes a video signal processing unit (not shown) for converting a video signal transmitted from each video conference terminal into a video signal format appropriate to the video conference. In Figure 1, the dotted lines represent coded video signals transmitted from the terminals to the MCU, and the solid lines represent re-coded video signals transmitted from the MCU to the terminals.

[7] Figure 2 is a block diagram of a video signal processing operation performed by an MCU in accordance with the related art. As shown, the MCU includes a decoding unit 21, a down scaling unit 22, a re-coding unit 23, and a mixer 24. The decoding unit decodes a video signal received from a plurality of video conference terminals into DCT (discrete cosine transform) signals or pixel units. The down scaling unit reduces resolution of a decoded signal outputted from the decoding unit. The re-coding unit re-codes each video signal outputted from the down scaling unit 22. And, the mixer mixes video signals coded through the re-coding unit and transmits it to the video conference terminals.

[8] Referring to Figure 3, the decoding unit 21 includes an inverse VLC (variable length coding) unit 21a for performing inverse VLC of a coded video signal transmitted

from the video conference terminal, an inverse DCT (discrete cosine transform) unit 21b for performing inverse DCT of an output signal of the inverse VLC unit 21b, and an inverse quantizing unit 21c for performing inverse quantization of an output signal of the inverse DCT unit 21b. The output signal of the inverse DCT unit 21b is output through the inverse quantizing unit 21c by pixel units.

[9] The down scaling unit 22 reduces resolution of the video signal output from the decoding unit 21 as 1/2, 1/4, ... , $1/2^n$, where n is natural number not less than 1.

[10] The re-coding unit 23 includes a quantizing unit 23a for quantizing an output signal of the down scaling unit 22, a DCT unit 23b for performing discrete cosine conversion of an output signal of the quantizing unit 23a, and a VLC unit 23c for performing variable length coding of the output signal of the DCT unit 23b.

[11] Operation of the related-art MCU will now be described. Initially, plural video signals input from each video conference terminal to the decoding unit 21 are decoded into a DCT domain or a pixel domain. A resolution reduction algorithm is applied to each output signal of the decoding unit 21 in the down scaling unit 22, and each output signal is re-coded in the re-coding unit 23. The video signals output from the re-coding unit 23 are mixed and the resulting signal is transmitted to the video conference terminals. In performing DCT domain processing, each video signal transmitted to the decoding unit 21 passes through the inverse DCT unit 21b. In performing pixel domain processing, each video signal received by the decoding unit 21 passes through the inverse quantizing unit 21c.

[12] Both the video signal decoding process through the inverse DCT unit 21a and the inverse quantizing unit 21b and the video signal coding process through the quantizing

unit 23a and the DCT unit 23b include loss coding characteristics. In the related-art MCU described above, by applying decoding and coding having loss coding characteristics consecutively for video signal processing, picture quality may be deteriorated.

[13] In addition, in the related-art MCU, by processing a video signal through the inverse DCT unit, the inverse quantizing unit, the quantizing unit and the DCT unit consecutively, video signal processing time may be delayed. More specifically, because video signal processing is performed only by the MCU, the time required for performing video signal processing may be delayed and picture quality of the processed video signal may be deteriorated.

SUMMARY OF THE INVENTION

[14] An object of the present invention is to overcome one or more problems of the related art described above.

[15] Another object of the present invention to provide a system and method for processing digital video signals more efficiently for purposes of providing a multipoint video conference service to a plurality of terminals.

[16] Another object of the present invention is to implement the aforementioned system and method in a mobile communication system, wherein the conference terminals include one or more mobile communication terminals.

[17] In order to achieve these and other objects and advantages, the present invention provides in one embodiment a digital video signal processing apparatus for a mobile communication system which includes plural video conference terminals each having

a video camera, and an MCU (multipoint control unit) for mixing video signals received from the video conference terminals and transmitting the mixed signal to each of the video conference terminals.

[18] A digital video signal processing apparatus for a mobile communication system in accordance with another embodiment of the present invention includes a converter for converting a video signal received through a video camera into a digital video signal; a down scaling unit for reducing resolution of the digital video signal; an encoding unit for compressing an output signal of the down scaling unit and transmitting it through a transmitting unit; an inverse VLC unit for decoding a received video signal through inverse variable length coding; an address setting unit for setting a macroblock address of a video signal outputted from the inverse VLC unit; a VLC unit for compressing an address set-video signal through variable length coding; and a mixer for outputting a final image by mixing plural video signals.

[19] A digital video signal processing method for a mobile communication system in accordance with another embodiment of the present invention includes reducing resolution of a video signal taken by a video camera and transmitting it to a MCU (multipoint control unit); and transmitting a final image obtained by mixing/arranging received video signals to each video conference terminal.

[20] A digital video signal processing method for a mobile communication system in accordance with another embodiment of the present invention includes converting a video signal received through a video camera into a digital video signal format; reducing resolution of a digital video signal; compressing the resolution-reduced video signal and

transmitting it to a MCU (multipoint control unit); decoding each video signal through inverse variable length coding by the MCU; setting a macroblock address of the decoded video signal; encoding each video signal through variable length coding; and mixing encoded each video signal and transmitting it to the video conference terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

[21] Figure 1 is a block diagram illustrating the general configuration of a multipoint video conference system;

[22] Figure 2 is a block diagram illustrating a construction of a MCU (multipoint control unit) of the system in accordance with the related art;

[23] Figure 3 is a block diagram illustrating a detailed construction of the MCU in Figure 2;

[24] Figure 4 is a block diagram illustrating a video conference terminal in accordance with and embodiment of the present invention;

[25] Figure 5 is a block diagram illustrating one possible construction of a MCU (multipoint control unit) in accordance with the present invention;

[26] Figure 6 illustrates a position of a macroblock processed in an address setting unit of the MCU in accordance with the present invention;

[27] Figure 7 is a flow chart showing steps included in a digital video signal processing method for a mobile communication system in accordance with an embodiment of the present invention; and

[28] Figure 8 shows an example of a final image that may be obtained by mixing resolution-reduced video signals in accordance with the system and method of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[29] A digital video signal processing apparatus of a mobile communication system in accordance with one embodiment of the present invention includes plural video conference terminals each having a video camera and an MCU (multipoint control unit) for generating a new video signal obtained by mixing video signals from the video conference terminals then transmitting the new video signal to each of the video conference terminals. In the MCU in accordance with the present invention, a down scaling process is not performed in the MCU as is the case with the related art. Instead, the down scaling process is performed in each of the video conference terminals.

[30] Figure 4 is a block diagram of a video conference terminal in accordance with the present invention. This terminal includes a converter 110 for converting an image of one or more video conference participants input through a video camera into a format for digital video signal processing. A down scaling unit 120 reduces resolution of the video signal output from the converter 110 and an encoding unit 130 codes the video signal output from the down scaling unit 120 in accordance with a predetermined video standard such as but not limited to the MPEG-4 standard. Transmitting unit 140 transmits the video signal output from the encoding unit 130 to an MCU.

[31] The image received through the video camera may be a VGA (video graphic array) signal in an RGB (Red-Green-blue) format. This signal is converted into a VGA signal of a YCbCr format through the converter 110. Herein, the YCbCr format is a format for digital video signal-processing a RGB format video signal, where Y indicates a luminance signal and Cb and Cr indicate color difference signals.

[32] The down scaling unit 120 reduces resolution of the YCbCr format VGA signal output from the converter 110 into a YCbCr format with reduced resolution QVGA (quarter VGA) signal. The QVGA signal output from the down scaling unit 120 is transmitted to the MCU by unit 140, after passing through the encoding unit 130. The down scaling unit 120 may reduce resolution of the video signal in accordance with any one of a variety of techniques, including but by no means limited to applying a sub-sampling method or a down-sampling method.

[33] Figure 5 is a block diagram illustrating an embodiment of an MCU in accordance with the present invention. The MCU includes inverse VLC units 210 for performing inverse variable length-coding for respective video signals received from the video conference terminals, address setting units 220 for designating macroblock addresses of respective signals outputs from the inverse VLC units 210, and VLC units 230 for variable length-coding respective video signals output from address setting units 220. A mixer 240 mixes the video signals output from the VLC units 230 based on domain arrangement.

[34] The MCU preferably mixes only the resolution-reduced video signals received from the video conference terminal and transmits the mixed signal to each of the video conference terminals. Because it is possible to perform the mixing process in a VLC region,

there is no need to perform decoding a pixel domain or a DCT domain. Accordingly, the MCU of the present invention may include only an inverse VLC unit 210 for performing a no-loss coding process and a VLC unit 230.

[35] The address setting unit 220 sets a macroblock address by considering where an image transmitted from each video conference terminal is to be arranged at a position within a final video image. MB_addr_increment field preferably exists in an MPEG standard syntax and reduces a code quantity by coding not a present macroblock absolute address but a difference value (different) from a previous macroblock address.

[36] Figure 6 illustrates exemplary positions of macroblocks processed in the address setting unit in accordance with the present invention, where there are four video reference participants. As shown, the final image includes an image of each of the four participants. To reduce a code quantity, an absolute address is set by applying a MB_addr_adjust block only for an address of a macroblock placed at the left of each slice and an address difference value is coded in the rest macroblocks. Accordingly, computational complexity can be reduced. Herein, the MB_addr_adjust block designates an absolute address of a macroblock in consideration of an arrangement in a final video image mixed in the MCU.

[37] More specifically, the MB_addr_adjust block is not applied for all macroblock addresses respectively positioned at the left of four images. Instead, the MB_addr_adjust block is applied only for a macroblock address existing on the left in a final image. In a macroblock address existed on the right in the final image, a difference value (different) from a previous macroblock is coded-displayed as a MB_addr_increment field.

[38] Figure 7 is a flow chart showing steps included in a digital video signal processing method of a mobile communication system in accordance with an embodiment of the present invention. The method includes each video conference terminal reducing resolution of a video signal received through a video camera and then transmitting the reduced-resolution video signal to the MCU. The MCU then mixes the reduced-resolution video signals received from each terminal to generate a final composite image and then transmitting the final image to each video conference terminal. This method is described in greater detail below.

[39] First, a video signal is input from a video camera located within or coupled to the video conference terminal in real-time, as shown at step S1. The video signal is converted into a signal for digital signal processing in the converter 110, as shown at step S2. More specifically, the converter 110 converts an input RGB format VGA signal into a YCbCr format VGA signal.

[40] Resolution of the YCbCr format VGA signal output from the converter 110 is then reduced in down scaling unit 120 and output preferably as a YCbCr format QVGA signal, as shown at step S3. The resolution-reduced digital video signal may be compressed, for example, through a MPEG-4 coding process, as shown at step S4. The compressed video signal is then transmitted to the MCU, as shown at step S5.

[41] In the MCU, the video signal transmitted from each video conference terminal is inverse variable length-coded, as shown at step S6. A macroblock address of the video signal output from the inverse VLC unit 210 is then determined according to an arrangement region (i.e., a position where an image corresponding to the video signal is to

appear) in a final image, as shown at step S7. Setting the macroblock address of the video signal in the address setting unit 220 will now be described in detail.

[42] By considering an arrangement position of each image transmitted from the four video conference terminals, an absolute address is designated only for a macroblock at the left of each slide. An address increase value is set for the rest macroblocks except the macroblock at the left. Accordingly, by not setting an absolute address for all macroblocks but coding an address increase value, it is possible to reduce computing process and data quantity required for designating a macroblock address.

[43] The output signal of the address setting unit 220 is variable length coded in the VLC unit 230, as shown at step S8. The signals output from the VLC unit 230 are then mixed in mixer 240, as shown at step S9, and a final composite image output from the mixer is transmitted to each video conference terminal, as shown at step S10. Herein, the video signal output from the mixer 240 forms one final image consisting of four images.

[44] Figure 8 shows an example of a final image obtained by mixing resolution reduced video signals received from the four terminals, in the manner previously described.

[45] In the digital video signal processing apparatus and method of the present invention, video signals are consecutively processed through an inverse VLC unit according to a no-loss coding process and then through a VLC unit. With this arrangement, it is possible to prevent picture quality deterioration.

[46] In addition, through the address setting unit and the VLC unit, it is possible to reduce video signal processing time and computational complexity of the MCU and accordingly signal processing efficiency can be improved.

[47] More specifically, it is possible to implement video signals having higher picture quality and less delay in a multipoint video conference system using the present invention compared with the related art.

[48] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures.